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(54) Simulating steering feel system

(57) A simulated steering feel system 10 for use in a vehicle, Laboratory Simulator, or entertainment device employs a servo disk motor 14. The servo disk motor 14 is utilized to import improved torque feedback to a steering wheel or input device.

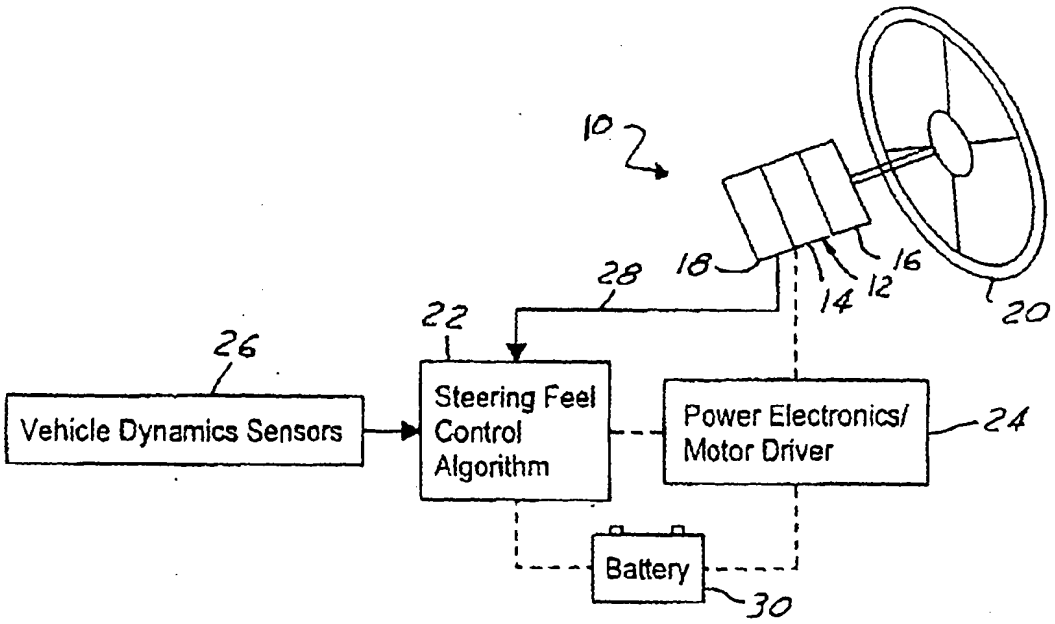

FIG. 1

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Description

Technical Field

[0001] The present invention relates generally to a simulated steering feel system and more particularly to a simulated steering feel system utilizing a servo disk motor.

Background Of The Invention

[0002] The use of simulated steering feel systems (SSFS) is well known in the prior art. SSFS's are presently used for a variety of applications including automotive drive simulators, engineering research tools, and entertainment devices. In addition, as advancements in automotive design continue to progress, advancements such as steer by wire (SBW) will likely require SSFS's in order to provide "road feel" or feedback response to a driver.

[0003] Although new improved uses of SSFS's will continue to develop, current SSFS can have undesirable characteristics. Current SSFS designs commonly use conventional brush or brushless electric motors. Such conventional electric motors can have disadvantages. Often conventional electric motors add undesirable weight to the SSFS's. Application work requirements can also lead to the need for undesirably large and heavy conventional motors. The high inertia of some conventional motors can also limit the acceleration capabilities of conventional motors and thereby limit the performance characteristics of the SSFS's in which they are used. In addition, conventional motors can create torque ripple or "cogging" effects which are highly undesirable.

[0004] It would, therefore, be highly desirable to have a simulated steering feel system with reduced size and weight and that contains further improvements over present SSFS designs utilizing conventional brush or brushless motors.

Summary of the Invention

[0005] It is therefore an object of the present invention to provide a simulated steering feel system that allows for reduced size, increased performance, and eliminates cogging.

[0006] In accordance with the objects of the present invention, a simulated steering feel system is provided. A simulated steering feel system includes a servo disk motor. The servo disk motor is utilized to allow feedback torque to a steering wheel. Using this servo disk motor, road feel can be imparted to the steering wheel from a small reduced weight package with improved performance.

[0007] Other objects and features of the present invention will become apparent when viewed in light of the detailed description of the preferred embodiment when taken in conjunction with the attached drawings and appended claims.

Brief Description Of The Drawings

[0008]

FIGURE 1 is an embodiment of a simulated steering feel system in accordance with the present invention for use in an automobile; and
FIGURE 2 is an embodiment of a simulated steering feel system in accordance with the present invention for use in a driving simulator.

Description Of The Preferred Embodiment(s)

[0009] Referring now to Figure 1, which is an illustration of an embodiment of a simulated steering feel system 10 in accordance with the present invention. The embodiment illustrated in Figure 1 is preferably for use in an automobile to be used in conjunction with the steer by wire system, although the illustrated embodiment can be used in conjunction with any automotive system where simulated steer feel is desired. In an alternate embodiment, whose descriptions will follow, the simulated steering feel system 10 can be used in a variety of applications, including applications independent of an automobile.

[0010] The simulated steering feel system 10 includes a servo disk actuator 12. In its basic form, the servo disk actuator 12 includes at least one servo disk motor 14. Servo disk motors are well known in the electronic industry. Servo disk motors are also commonly referred to as disk motors, printed circuit board motors, or pancake motors. One advantage of using a servo disk motor, is that servo disk motors provide higher torque with a smaller package than conventional electric motors. In addition, servo motors do not suffer from torque ripple or cogging effects commonly found in conventional electric motors. Servo disk motors also provide smoother torque with improved acceleration. Although the servo disk actuators 12 can include only a servo disk motor 14, alternate embodiments may include additional components.

[0011] In one embodiment, the servo disk actuator 12 can additionally include a torque multiplier 16. Torque multipliers are well known in the prior art. Torque multipliers 16 commonly consist of pulleys, belts, or gear reducers, although a variety of torque multipliers 16 are known. It is known that torque multipliers 16 can be combined with servo disk motors 14 to magnify the torque generated by the servo disk motor 14. It is known that torque multipliers 16 are available in a variety of reduction ratios. Common ranges of reduction ratios vary from 10:1 to 100:1, although additional reduction ratios are possible.

[0012] In still another embodiment, the servo disk actuator 12 can include a steering wheel sensor 18. The

steering wheel sensor 18 can be utilized to measure a variety of characteristics of a steering wheel 20 including, but not limited to, angle, velocity, acceleration, and torque of the steering wheel 20. In other embodiments, the steering wheel sensor 18 and the steering wheel 20 may be replaced by any known input device sensor (not shown) and corresponding input device (not shown) such as a joystick or similar game device.

[0013] The simulated steering feel system 10 can further include a steering feel control processor 22. In one embodiment, the steering feel control processor 22 is a dedicated processor utilized to control the servo disk motor 14. In alternate embodiments, the steering feel control processor 22 was simply the function of a larger automotive computer system.

[0014] Although the steering feel control processor 22 can be utilized to directly control the servo disk actuator 12, in alternate embodiments, a motor driver element 24 may be used in conjunction with the steering feel control processor 22 to control and power the servo disk motor 14. The simulated steering feel system 10 can additionally include at least one vehicle dynamic sensor 26. Vehicle dynamic sensors 26 can be used in a variety of automotive environmental conditions, including but not limited to, vehicle speed, vehicle acceleration, tire load, road feel, external temperature, surface friction, wheel slip angle, and wheel position. The steering feel control processor 22 uses information provided by the vehicle dynamic sensors 26 to determine an appropriate feedback torque or "road feel". The steering control processor 22 then utilizes servo disk actuator 12 to impart such "road feel" to the steering wheel 20 or other input device.

[0015] In an alternate embodiment, the steering feel control processor 22 may further receive steering wheel information 28 from the steering wheel sensor 18 and use this information in combination with the information provided by vehicle dynamic sensors 26 to create a closed loop system wherein "road feel" is further improved.

[0016] The use and feel of such steering feel control processors 22 is well known in the prior art. Although the simulated steering feel system 10 may be powered by a variety of sources, in one preferred embodiment, the simulated steering feel system 10 is powered by an automotive battery 30.

[0017] Although the simulated steering feel system 10 has thus far been described in terms of an in vehicle system, the simulated steering feel system 10 can be used in a variety of other applications. Such additional applications can include, but are not limited to, laboratory testing of steering feel tuning, automotive driving simulators, or entertainment devices (such as arcade games or home entertainment units). When used in such applications, a steering feel control processor 22 can be any controlling computer device. In addition, vehicle dynamic sensors 26 can be replaced by vehicle dynamic models 32, or other informational sources containing information on "road feel" (see Figure 2). The vehicle dynamic models 32 can consist of automotive performance models or gaming simulation data, or a variety of other informational sources. In addition, in these embodiments, it is contemplated that the simulated steering feel system 10 may be powered by any acceptable power source.

[0018] While the invention has been described in connection with one or more embodiments, it is to be understood that the specific mechanisms and techniques which have been described are merely illustrative of the principles of the invention. Numerous modifications may be made to the methods and apparatus described without departing from the spirit and scope of the invention as defined by the appended claims.

Claims

1. A simulated steering feel system comprising:

   a servo disk motor, said servo disk motor capable of imparting feedback torque to an input device.

2. A simulated steering feel system as described in claim 1 further comprising a steering feel control processor.

3. A simulated steering feel system as described in claim 1 further comprising at least one vehicle dynamic sensor.

4. A simulated steering feel system as described in claim 1 further comprising:

   a torque multiplier, said torque multiplier utilized to magnify torque generated by said servo disk motor.

5. A simulated steering feel system as described in claim 4 wherein said torque multiplier is a gear reducer.

6. A simulated steering feel system as described in claim 1 wherein said input device is a steering wheel.

7. A simulated steering feel system as described in claim 1 further comprising a steering wheel sensor element.

8. A simulated steering feel system as described in claim 1 for use in a driving simulator.

9. A simulated steering feel system as described in claim 1 for use in an entertainment device.

10. A simulated steering feel system as described in claim 1 for use in an automobile in conjunction with a steer by wire system.

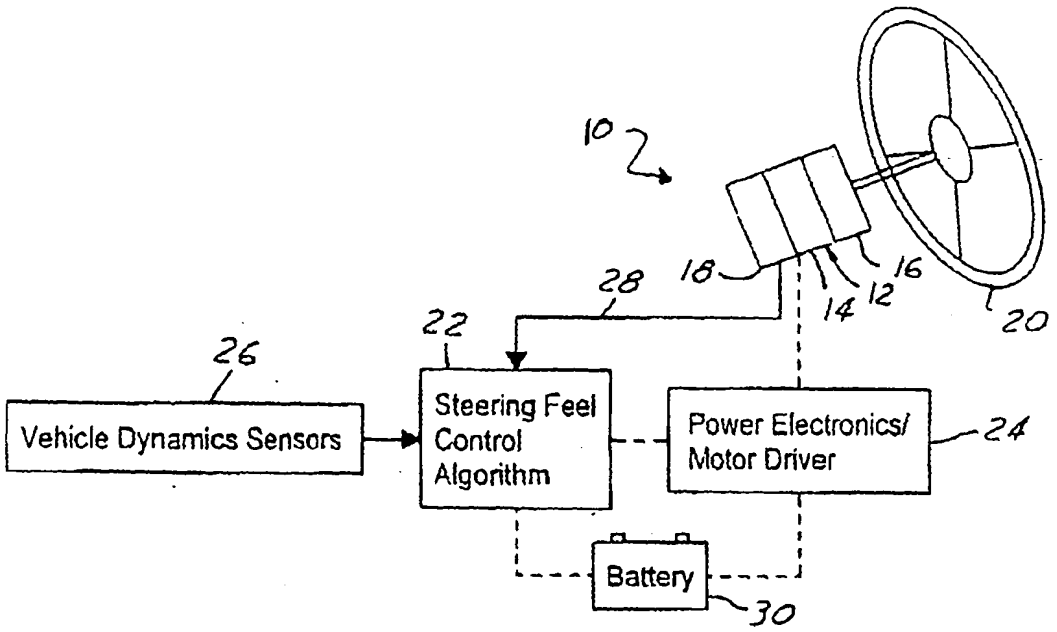

FIG. 1

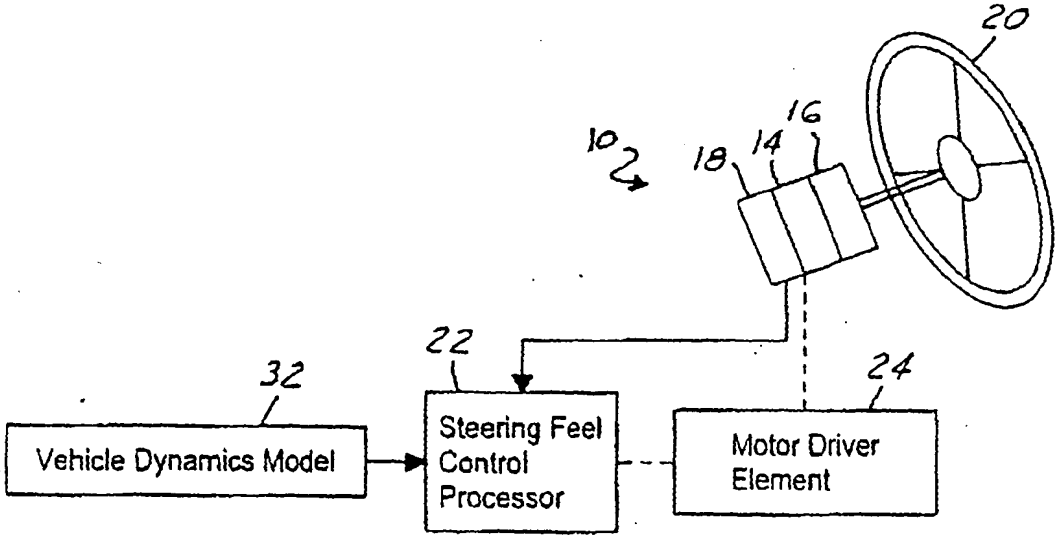

FIG. 2

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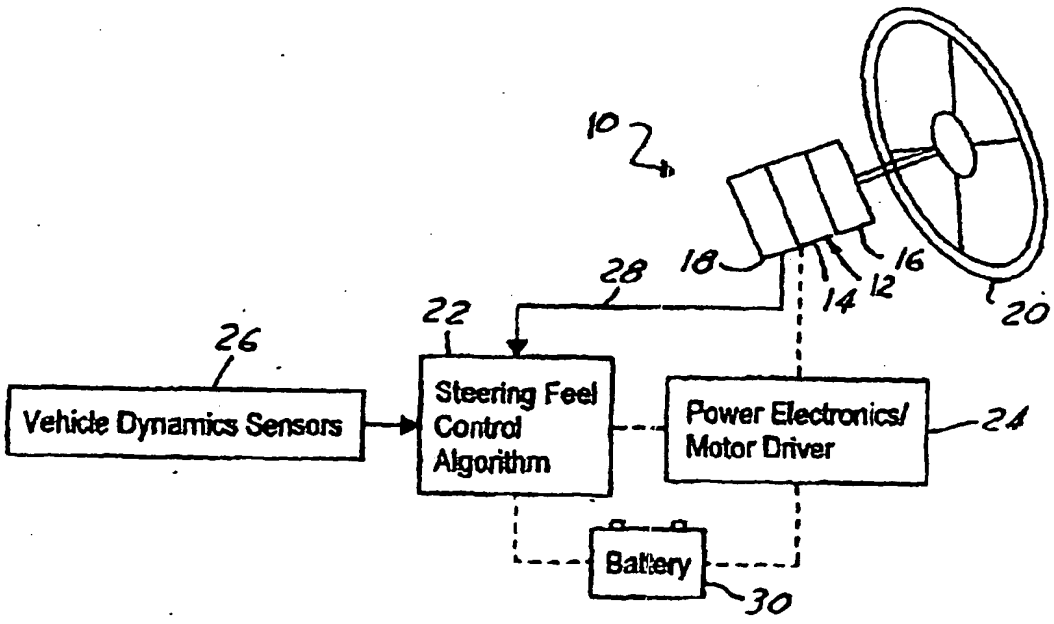

FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 01 12 5268

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	DE 199 12 169 A (BOSCH GMBH ROBERT) 6 July 2000 (2000-07-06) * page 2, line 31 - line 56; figures *	1-10	B62D5/04
X	DE 198 04 821 A (TOYOTA MOTOR CO LTD) 13 August 1998 (1998-08-13) * page 2, line 43 - page 3, line 16; figures *	1-10	
X	US 5 097 917 A (SATO MAKOTO ET AL) 24 March 1992 (1992-03-24) * column 1, line 51 - column 2, line 6; figures *	1-10	
X	US 6 095 277 A (BOHNER HUBERT ET AL) 1 August 2000 (2000-08-01) * column 2, line 45 - column 3, line 8; figures *	1-10	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B62D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 December 2004	Daehnhardt, A

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 12 5268

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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08-12-2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19912169 A	06-07-2000	DE 19912169 A1	06-07-2000
		JP 2000198453 A	18-07-2000
		US 6219604 B1	17-04-2001
DE 19804821 A	13-08-1998	JP 3517863 B2	12-04-2004
		JP 10217998 A	18-08-1998
		DE 19804821 A1	13-08-1998
		US 6213248 B1	10-04-2001
US 5097917 A	24-03-1992	JP 1172071 A	06-07-1989
		JP 1172057 A	06-07-1989
		JP 2534287 B2	11-09-1996
US 6095277 A	01-08-2000	DE 19650475 C1	16-04-1998
		FR 2756799 A1	12-06-1998
		GB 2320003 A ,B	10-06-1998
		IT RM970748 A1	05-06-1998
		JP 3008090 B2	14-02-2000
		JP 10226353 A	25-08-1998

EPO FORM P0459

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